

Advanced Concepts for Electron-Ion Colliders

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Abstract

Possible advances in the electron-ion collider concepts are considered that would allow one to enhance the efficiency of utilization of polarized electron and ion beams and raise the luminosity potentials.

Superconducting energy recovering 5 to 10 GeV linac (ERL) was proposed earlier as an alternative to electron storage rings to deliver polarized electron beam for electron-ion collider (EIC, 30 to 50 GeV or higher energy of ion beam). It is proposed to compliment the ERL by electron circulator ring wherein the injected electron bunches will experience a large number of revolutions colliding with the ion beam. In this way, electron photo injector and linac operate in pulse current energy recovery regime of a relatively low average current value, while a high current circulates in collider. The polarization is still easily delivered and preserved. This scheme can be naturally converted to the pure linac-ring scheme when beneficial.

To make it also easier the delivery and manipulation the proton or light ion spin polarization, twisted (figure 8) synchrotrons are proposed for heavy particle booster and collider rings. Same type of the beam orbit can be used then for electron circulator.

Electron cooling of the ion beam is considered an inevitable component of high luminosity EIC ($10^{33}/\text{cm}^2\cdot\text{s}$). It is recognized that electron cooling also gives a possibility to obtain very short ion bunches, that allows much stronger final focusing. At the same time, short bunches make feasible the crab crossing and traveling focus for ion beam at interaction point, hence, allow maximizing the collision rate and luminosity. As result, one can anticipate the luminosity increase by one or two orders of value.

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